

Life History and Biology of *Pyrausta orphisalis* Walker (Lepidoptera: Pyralidae) on Mint in Washington¹

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Abstract.—*Pyrausta orphisalis* Walker is a foliage feeder of spearmint and peppermint in Washington during its larval stages. Three generations occur per year, with typically five larval instars per generation. The life history of each generation is illustrated and various biological data are provided, viz., information on flight behavior, mating, adult longevity, ovipositional behavior, fecundity, immature development, larval habitat, feeding damage, overwintering, and natural enemies.

Pyrausta orphisalis Walker is a small (wing span, 14–16 mm), distinctive, orange and brown day-flying moth, which according to Munroe (1976) occurs along Canada's southern tier from Newfoundland to the Fraser Valley of British Columbia, south to northern Florida, the Sierra Blanca of New Mexico, Sonoma and Modoc counties, California. The moth frequents commercial mints [Scotch spearmint (*Mentha spicata*), native spearmint (*M. cardiaca*), and peppermint (*M. piperita*)] for nectar and oviposition, and at times, may be observed by the hundreds in flight in the field. Population levels will vary from year to year and between areas in Washington. The larvae feed on mint foliage and have been considered economically important on occasion by growers.

Descriptions of the life stages of *P. orphisalis* have been reported previously (Walker, 1859; Munroe, 1976; Campbell and Pike, 1984), but little information has been published on the life history or biology of the insect. Frick (1961) mentioned that there appear to be three generations a year, that the larvae feed on the terminal growth of mint, and that adults are sometimes extremely numerous in August. The purpose of our study was to document the life history and basic biology of *P. orphisalis*. Our principal objectives were to determine 1) the number of generations per year and seasonal occurrence of each, 2) mating behavior, oviposition, and fecundity, 3) larval behavior and feeding damage to mint, 4) the developmental times for immatures, 5) the overwintering stage, 6) adult flight behavior and longevity, and 7) the natural enemies of *P. orphisalis*. Voucher specimens are on deposit at the Washington State University, Irrigated Agriculture Research and Extension Center, Prosser, Washington.

MATERIALS AND METHODS

Field and laboratory studies were conducted over a 2-year period (1981–1982) at the Washington State University, Irrigated Agriculture Research and Extension

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Center, Prosser. Where practical, observations and studies of *P. orphisalis* were carried out on mint under cultivated field conditions. It was often necessary, however, to observe the same individuals over time, which required the use of cages or containers to confine the insect. For the field, cylinder cages (15-cm diameter, 30-cm height), constructed of cellulose-nitrate plastic and vented at the top with saran screening (400- μ m mesh), were employed unless stated otherwise; for the laboratory, clear plastic (5-cm diameter, 2-cm height) or glass (5-cm diameter, 2-cm height) petri dishes or cylinder cages (15-cm diameter, 30-cm height, 2.5 \times 2.5-cm wire mesh covered with plastic wrap) were used. All adults and immatures observed in the laboratory were held or cultured under a light and temperature regime of 16/8 hr (light/dark) and 23–28°C/20.5°C, respectively.

The general life history and habits of *P. orphisalis*, including the occurrence in time of its different life stages and number of generations per year, were determined on the basis of near-daily (May to September) or weekly (April, September to mid-November) field observations and sampling of spearmint and peppermint. Mint cuttings, sampled randomly from the field, were usually viewed with a hand lens or binocular microscope to detect eggs and distinguish first and second larval instars; third, fourth, and fifth instars, prepupae, pupae, and adults were discernible without magnification. The overwintering stage of *P. orphisalis* was determined by periodic inspection (October through February) of caged mint, stocked heavily in late August with second generation adults (100+/cage, two cages used, each 1.0 \times 0.5 \times 0.5 m).

Mating, ovipositional period, and fecundity were studied using virgin females paired with males held on mint under laboratory cage, or on mint leaves in petri dishes. Fecundity was also assessed on the basis of eggs dissected from virgin females, reared from collected ultimate instars previously held for ca. 1 week on caged mint in the field. Egg placement on the plant was determined by field observation, and systematic sampling and evaluation of mint cuttings. Egg eclosion and mortality were evaluated from eggs on mint in the field and the laboratory.

The developmental times for immatures were determined mainly from laboratory studies. The feeding sites and habits of each instar were determined through field observation, as were data on pupation.

Parasitoids were reared from host larvae in the laboratory and subsequently identified by specialists (Table 1). Predator information was derived from field observations.

RESULTS AND DISCUSSION

There were three generations of *Pyrausta orphisalis* that developed annually in Washington. The life history of each is illustrated in Figure 1. The overall generation times (in terms of length) were quite similar for the first two generations, but substantially longer for the third. Similarly, field developmental times, in terms of equivalent immature life stages for the first and second generations, as well as the egg, first, second, and third larval instars of the third generation were quite comparable; the fourth and fifth larval instars and prepupa of the third generation, however, required more time to develop than their earlier equivalents, perhaps due to cooler seasonal temperatures. There was overlap in life stages within and between generations, particularly during the summer (Fig. 1). Nonetheless, there were peak periods of abundance for each life stage in each generation,

Table 1. Parasitoids of *Pyrausta orphisalis* Walker in Washington reared from field-collected host larvae, Prosser, 1981–1982.¹

<i>P. orphisalis</i> instar	No. reared	No. parasitized	% para- sitized	% of total parasitization				Unknown tachinid sp. ⁴
				<i>P.</i> <i>spinator</i> ²	<i>Cotesia</i> sp. ³	<i>M. cam- pestris</i> ³	<i>S.</i> <i>bilineatus</i> ²	
I	50	1	2	100	—	—	—	—
II	81	3	4	100	—	—	—	—
III	191	20	10	75	20	5	—	—
IV	218	48	22	71	23	6	—	—
V	384	43	11	78	10	10	1	1
Total or \bar{x}	924	115	12	74	17	7	1	1

¹ Identification of Ichneumonidae by Drs. J. R. Barron and J. E. H. Martin, Biosystematic Res. Instit., Agric. Canada, Ottawa, Ont., Canada; Braconidae by Dr. P. M. Marsh, Systematic Entomology Lab., USDA, Beltsville, Md.

² Hymenoptera: Ichneumonidae.

³ Hymenoptera: Braconidae.

⁴ Diptera: Tachinidae.

e.g., first generation, first instar larvae in 1982 were most prevalent during the first week in June, though some were present before and after that date. Overwintering by the third generation prepupa began in October or November, followed by pupation in April or May, and finally adult emergence in May.

The moth is diurnal; white/blacklight traps operated nightly (concurrent with peak daytime flight periods) yielded negative results. Striking orange and brown coloration made the moth distinctive in the field coupled with its characteristic short, often jerky, rapid flight. The moth seldom ventured far from mint fields, usually staying just above or within the mint’s upper canopy. Between flights, short resting periods by the moth commonly occurred on the undersides of mint leaves. Sound perception in adults was acute; a camera’s shutter click was sufficient to cause resting moths to take flight. Both sexes of the first two generations took nectar from mint flowers during daylight hours.

Mating was observed only in the afternoon and at dusk in the field. Periodically, large field aggregations of males (up to 100 estimated) were observed in flight around a female, or in flight near a mating pair usually hidden in mint foliage, suggesting the female released or used a sex pheromone to lure males. Males in aggregations, were observed with external genitalia extended. In the laboratory, once a male and female were paired, mating occurred within a period of a few hours to about 3 days, preceded by presumed calling of the female resting upside down from a plant or container and with its antovipositor extended. Copulation, which can last for nearly an hour, was initiated immediately upon approach by a male to a stationary female. During union, moths faced in opposite directions and generally moved about short distances. Mating occurred during the same day as emergence or anytime within the first 6 days following emergence.

Initial oviposition commenced generally two days after mating and lasted from 1 to 6 days, $\bar{x} = 3$ ($n = 8$). Fecundity, based on laboratory studies, was extremely variable ranging from 1 to 196 eggs, $\bar{x} = 115$ ($n = 9$). We also observed that unmated females deposited a few eggs. Dissected virgin females contained 17 to 75 mature eggs, $\bar{x} = 35.4$ ($n = 30$).

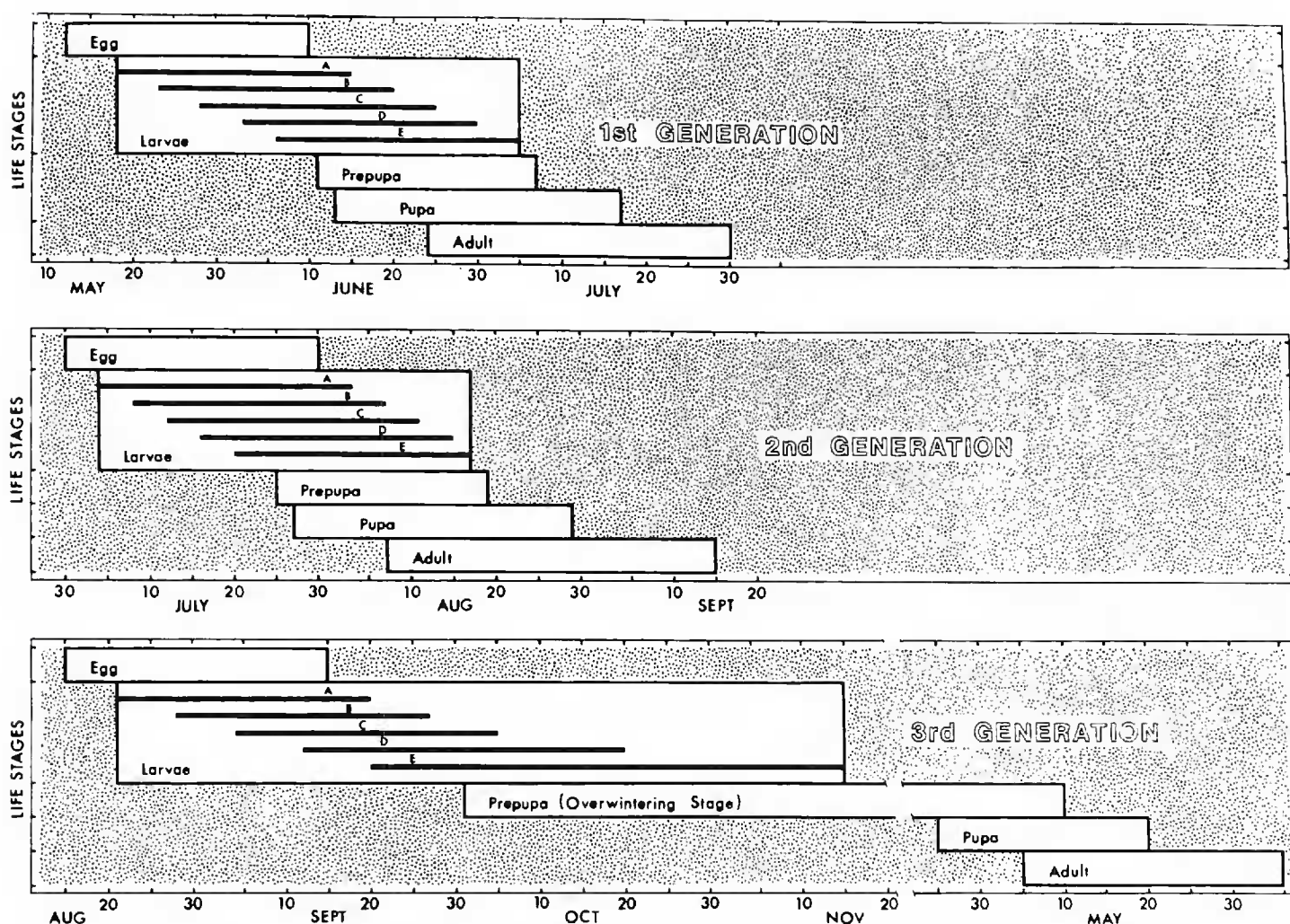


Figure 1. Life history and generations of *Pyrausta orphisalis* Walker in central Washington, 1981–1982 [n (2-year, 3-generation totals) = eggs, 719; larvae, 1717; adults, 3063].

Females lit frequently to oviposit in the field, usually depositing eggs singly, but occasionally in clusters of two to three. If four or more eggs occurred at one site on the plant, it was due to separate visits by the same or different moths. Females typically probed prospective sites with their antovipositors prior to egg deposition. Eggs ($n = 719$) were usually laid on leaf buds, small leaves subtending the buds, among flowers, and less frequently, on larger terminal leaves or stems. Interestingly, egg mortality appeared to be related to ovipositional site; egg mortality on larger leaves and stems reached ca. 60% ($n = 128$), while mortality for those among small terminal leaves and flowers was only 5% ($n = 509$). The appearance of unhatched eggs included partial clearing, collapse, color change to yellow or orange, no development, or partial development but without eclosion. In the laboratory, eggs hatched in ca. 4 days. The stemmata of the pharate larva became visible after 3 days and the head capsule darkened on the fourth.

Developmental time from egg to adult was temperature dependent; for larvae ($n = 70$) reared in cohorts at 28°C/20.5°C (16/8 hr, light/dark) in the laboratory, the mean was 32 days. For individually cultured larvae ($n = 17$) at 23°C/20.5°C (16/8 hr, light/dark), the mean was 38.5 days. Under July–August field conditions, the average total time was 34 days ($n = 70$). There were five larval instars in each generation. Based on laboratory studies, the stadia of the first four instars were ca. 4 ($n = 50$), 3.5 ± 0.7 ($n = 29$), 3.5 ± 1.1 ($n = 27$), and 4.0 ± 1.2 ($n = 24$) days, respectively. The fifth instar had two distinct phases, an actively feeding green-phase which lasted 5.3 ± 1.3 ($n = 24$) days, followed by a nonfeeding brown-

phase which lasted 1.8 ± 0.6 ($n = 24$) days. The prepupa and pupa lasted 1.7 ± 0.6 ($n = 19$) and 10.7 ± 0.6 ($n = 17$) days, respectively. Although five instars were typical, a sixth (male or female) occurred occasionally (Campbell and Pike, 1984). In such cases, the third and fourth instars lasted about 1 extra day, a green-phase fifth about a day shorter, followed by a green-phase sixth lasting about 5 days; the remaining stages were comparable to the "typical" individual. Since the sixth instar was uncommon it was not included in Figure 1. Adults used for studying fecundity lived 6 to 13 days, $\bar{x} = 9$ ($n = 13$). Virgin females, however, lived as long as 21 days.

Since eggs were usually laid singly, larvae were usually found one per branch terminal, but two to three were fairly common. Following eclosion, first instars bored into leaf buds or fed among the small subtending leaves. Feeding damage by the first instars was noticeable only with close inspection. Some peppermint plants showed a slight chlorosis at or near the point of feeding. First instars often inhabited and fed individually within single flowers making them difficult to detect. Prior to moulting, first instars constructed single loose-weave silk shelters in the bud or in the leaves directly below the bud. Ecdysis took place in the shelters followed by about one day of inactivity by the new larvae. The exuviae were usually consumed by the larvae.

The second instar was often found in the same locations on the plant as the first, except not usually inside the flowers. It often hid among the flowers and fed on the calyxes, or the basal aspects of the leaves. Third instars typically occurred among small leaves subtending the bud or among larger leaves. These larger leaves were often silked together by the larvae. Damage by this instar consisted of chewing holes or removing upper leaf tissue in transverse bands at mid-leaf, causing leaf dieback distal to the feeding. Leaves tied together by silk occurred not only with the first three instars, but also the fourth and fifth. These silked together leaves served not only as ecdysial shelters, but also retreats on and in which larvae fed. It was not uncommon for a single individual during feeding and development to construct several shelters. Fourth and fifth instars clearly caused the most plant damage. These latter instars were highly active and moved freely through the crop canopy, often feeding on several plants. Feeding ceased with the brown-phase fifth instar, which would leave the plant to construct pupal shelters on the soil. The shelters consisted of fallen mint leaves or soil particles silked together. Adults emerged through the proximal end of the pupal shelters.

A number of natural enemies were found associated with *P. orphisalis*. The reared parasitoids included ichneumonids, braconids, and a tachinid (Table 1). *Pristomerus spinator* Fabricius (Hym., Ichneumonidae) was the most predominant in the rearings. It parasitized commonly third through fifth instars, rarely first or second. Initial parasitization probably began with thirds, since they were the first to venture into the more open, vulnerable microhabitats. The host generally reached the pupal stage before death and eventual consumption by the parasitoid. *Cotesia* sp. (Hym., Braconidae) was about one-fifth as prevalent as *P. spinator*. It also attacked third through fifth instar larvae, but differed from *P. spinator* in that it caused death in the host earlier, generally by the fourth or fifth instar. *Cotesia* sp. pupated in a self-spun cocoon within a feeding shelter, but outside its host. *Meteorus campestris* Vier (Hym., Braconidae), a less abundant parasitoid than *Cotesia* sp., attacked third through fifth instar larvae and caused

death to the brown-phase fifth. Generally, the fifth completed its pupal shelter before death. Only single specimens of *Stictopisthus bilineatus* Thomson (Hym., Ichneumonidae) and an unknown tachinid fly were obtained in the rearings. Collectively, the five species encountered caused 12% mortality to *P. orphisalis* based on the findings averaged over the 2-year study.

Predators of *P. orphisalis* included minute pirate bugs, *Orius* sp. (Hemiptera: Anthocoridae), feeding on the eggs, and big-eyed bugs, *Geocoris* sp. (Hemiptera: Lygaeidae), reduviid hemipterans and thomisid spiders feeding on the larvae.

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